EE 101 Homework 1
Binary Representation
Redekopp

Name: _________________________________________
Due: See Blackboard
Score: ________

Only use a calculator to CHECK your work, not to DO your work.

Please post any questions regarding HW problems on Piazza.

HW 1a Blackboard Form – Positional Number Systems

1. [BB] (9 pts.) Perform the following number system conversions. Note: It may be easier to convert them to the desired base in a different order than shown here.
   a. 1100101.1011 \(_2\) = \(?\)\(_{10}\)
   b. 1A9.D\(_{16}\) = \(?\)\(_{10}\)
   c. 617\(_8\) = \(?\)\(_{10}\)

2. [BB] (6 pts.) Find the base (radix) of the following numbers given their decimal equivalents.
   a. 35\(_x\) = 26\(_{10}\)
   b. 1A5\(_x\) = 269\(_{10}\)

3. [BB] (4 pts.) How many bits are required to represent the following numbers in binary.
   a. A 4-decimal digit pin code
   b. The number of days in a year

HW 1b Blackboard Form – Number (Base) Conversion

1. [BB] (3 pts.) Convert the following decimal numbers using the division and multiplication method. You must show your work to receive credit.
   a. 97.8125\(_{10}\) = \(?\)\(_2\)
   b. 1337.625\(_{10}\) = \(?\)\(_8\)
   c. 61.64\(_{10}\) = \(?\)\(_5\)

2. [BB] (4 pts.) Let the constant PI be represented as 3.14\(_{10}\). How many bits of unsigned binary are required to represent 3.14\(_{10}\) to within -0.005 of error (i.e. 3.135 ≤ x ≤ 3.14, but not over 3.14)? What is your representation with that many bits?
   [Approach: Convert the integer portion…easy! Now convert the fractional part using the multiplication method. As you proceed you will start accumulating bits of the answer. Using their binary place values find the value of the fraction as you add in each new bit. Stop when you get to .135 or more.]
3. [BB] (9 pts.) An electronic timer updates the time every tenth of a second (0.1\textsubscript{10} seconds). However, 0.1\textsubscript{10} cannot be represented exactly in binary. Perform the following operations.
   a. Convert 0.1\textsubscript{10} to binary stopping after 9 bits to the right of the binary point (i.e. \(0.b_1 b_2 b_3 \ldots b_9\)). (5 pts.)
   b. What is the exact value of the binary result you just found? (1 pts.)
   c. If this value is used as an approximation to 0.1\textsubscript{10} and the timer updates the time using this value, how many seconds of error will accrue after 1 hour? (2 pts.)
   d. Now go to [http://www.ima.umn.edu/~arnold/disasters/patriot.html](http://www.ima.umn.edu/~arnold/disasters/patriot.html) to see how a similar error caused a major disaster. How many hours had the error been accumulating in this specific case? (1 pts.)

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**HW 1c Blackboard Form – Binary/Octal/Hexadecimal Conversion**

1. [BB] (6 pts.) Perform the following number system conversions. Note: It may be easier to convert them to the desired base in a different order than shown here.
   a. \(1100101.1011_2 = ?_8 = ?_{16}\)
   b. \(1A9.D_{16} = ?_8 = ?_2\)
   c. \(617_8 = ?_{16} = ?_2\)

2. [BB] (4 pts.) Perform the following binary/octet/hexadecimal conversions.
   a. \(2460.573_8 = ?_2 = ?_{16}\)
   b. \(ACE.FED_{16} = ?_2 = ?_8\)

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**HW 1d Blackboard Form – Binary Arithmetic & Signed Systems**

1. [BB] (8 pts.) Perform the following binary arithmetic (assuming all number are unsigned)? For addition your answer may extend to a 6\textsuperscript{th} bit. When performing subtraction use the borrow method.
   a. \(10110_2 + 00111_2 = ?\)
   b. \(11001_2 - 10111_2 = ?\)
   c. \(01101_2 * 01011_2 = ?\)
   d. \(11111_2 + 11111_2 = ?\)

2. [BB] (6 pts.) What are the corresponding decimal representations for the following binary strings: 10110110 , 11011011, if
   a. The binary numbers are using 8-bit unsigned format?
   b. The binary numbers are using 8-bit signed-magnitude format?
   c. The binary numbers are using 8-bit 2’s complement format?

3. [BB] (18 pts.) For each of the following decimal numbers find the corresponding 8-bit representation using the indicated systems. Note: Some numbers may NOT be representable w/ 8-bits. If that is the case just write “N/A”. Also find the minimum bits needed to represent the number in the 2’s complement system.
4. [BB] (11 pts.) How many bits are required to represent the following decimal numbers using the following systems.

<table>
<thead>
<tr>
<th>+43</th>
<th>-79</th>
<th>-128</th>
<th>+31</th>
<th>+103</th>
<th>-16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</table>

4. [BB] (11 pts.) How many bits are required to represent the following decimal numbers using the following systems.

<table>
<thead>
<tr>
<th>+128</th>
<th>-45</th>
<th>+352</th>
<th>+31</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

HW 1e Blackboard Form – Decimal Codes

1. [BB] (12 pts.) Decimal Codes: Perform the following conversions
   a. 1001 1011 0100\text{Excess}-3 = \text{?}_{\text{BCD}} = \text{?}_{s4-2-1} = \text{?}_{10}
   b. 2049_{10} = \text{?}_{\text{BCD}} = \text{?}_{s4-2-1} = \text{?}_{\text{Excess}-3}

Extra Credit:
2. [BB] (10 pts.) Do the following problem on a piece of paper and turn it in separately. How many bits are required to represent the decimal number 293 in the following systems:
   a. Unsigned binary (2 pts.)
   b. BCD (2 pts.)
   c. [Paper] Derive an expression for the number of bits required to represent a decimal number, \(d\), in BCD. To do this, recall that with \(m\) decimal digits we can represent a number up to \(10^m-1\). Derive another expression for the number of bits required to represent \(d\) in unsigned binary. To do this recall that with \(n\) bits we can represent a number up to \(2^n-1\). [You may use the ceiling function which rounds up to the nearest integer…\(\text{ceiling}(5.01) = 6\). Will representing a number in BCD ever require fewer bits than unsigned binary? Justify your response. (6 pts.)